Electronic Structure of the Stripe Phase in $La_{1.28}Nd_{0.6}Sr_{0.12}CuO_4$

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INTRODUCTION

The stripe phase first proposed to explain neutron data from Nd-substituted $La_{1.28}Nd_{0.6}Sr_{0.12}CuO_4$ (Nd-LSCO) represents a new paradigm of charge carriers in a solid.[1] Unlike conventional metals where the charge distribution is homogeneous, the stripe phase envisage microscopic antiferromagnetic domains separated by one-dimensional domain walls (stripes) consisting of hole carriers and frustrated spins. The implication of this charge segregation propensity on the conduction as well as the superconducting mechanism is at the heart of the current debate in high-T_c research today. So far, much of the stripe information stems from interpretation of the incommensurate neutron scattering peaks. Very little is known about the electronic structure of these materials. Here we report angle-resolved photoemission data that directly probe the electronic structure and charge dynamics of the stripe phase.

Experimental

Angle-resolved photoemission spectroscopy (ARPES) measures the single particle spectral function A(k, ω) weighted by the photoionization cross section. The ARPES data have been recorded at the beamline 10.0.1.1 HERS endstation of the Advanced Light Source.[2] 55eV (rather than the typical 20-25 eV) photon energy was used for more efficient k-space sampling. Using the angular mode of the Scienta analyser, the momentum resolution was 0.02π, improved from traditional value of 0.14π (the unit of the momentum is 1/a with a being the lattice constant). The energy resolution is detuned from its optimal 7 meV to 16 meV so that a few thousand spectra with sufficient statistics can be obtained during the lifetime of a cleaved surface. For example, the 500 spectra presented in Fig. 1 were recorded within the first 3 hours after the cleaving. The vacuum during the measurement was 2-5 X 10^{-11} Torr. The Nd-LSCO sample was grown using the travelling floating zone method. The same class of samples has been used for neutron scattering experiments.[1]

Results and Discussion

Fig. 1 presents typical ARPES spectra of Nd-LSCO sampled from the first and fourth quadrants of the Brillouin Zone (BZ) at a temperature of 20 K. Using the angular mode of the analyser, we can sample nearly a whole quadrant along k_x with 48 points at the same time, which correspond to the spectra in one panel (1 to 10); the whole Brillouin zone is then measured by taking various k_y cuts. It is clear from the figure that the spectra do not contain peak structure anywhere in the

BZ - a behavior which is quite different from the Fermi Liquid. Nevertheless, the data still show edge or cusp-like structures with clear angular dependence. As k_x moves from 0.10π to 1.17π, a broad feature moves from 200 meV or deeper towards the Fermi level E_F and stays there for an extended region near $k_x = \pi$. The detailed discussion of the peculiar electronic structure will be described elsewhere.

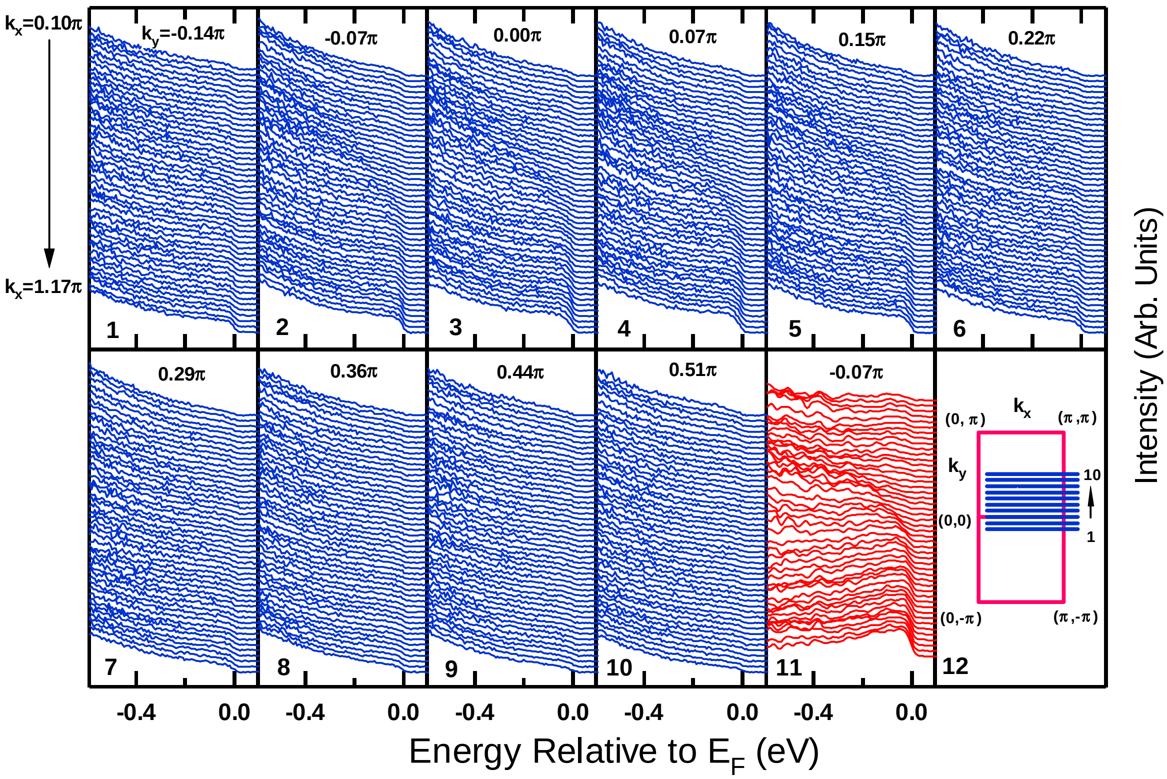

Figure 1. Angle-resolved photoemission spectra taken on Nd-LSCO at 20K. The measurement scheme is depicted in panel 12 which covers part of the first and fourth quadrants. Each of the panels 1-10 represents a cut along (0,0) to (π,0) direction with k_x covering from 0.10π to 1.17π, while panels 1 to 10 represents 10 cuts along (0,0) to (0,π) direction, with k_y covering from -0.14π to 0.51π. Panel 11 shows the same spectra in panel 2 but with the high energy background removed.

REFERENCES

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